MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

PIP 0255 - INTRODUCTION TO PHYSICS

(Foundation in IT Students only)

12 JULY 2023
9.00 a.m – 11.00 a.m
(2 hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of **5** pages only (excluding cover page and appendices page) with **5** Questions only.

2. Answer **ALL FIVE** structured questions. All questions carry equal marks and the distribution of the marks for each question/section is given.

3. Please print all your answers in the Answer Booklet provided.

STRUCTURED QUESTIONS [5 questions × 10 MARKS = 50 MARKS in TOTAL]

Instruction: Answer **ALL FIVE** questions. *Provide your calculation steps whenever possible.*

Question 1 (10 marks)

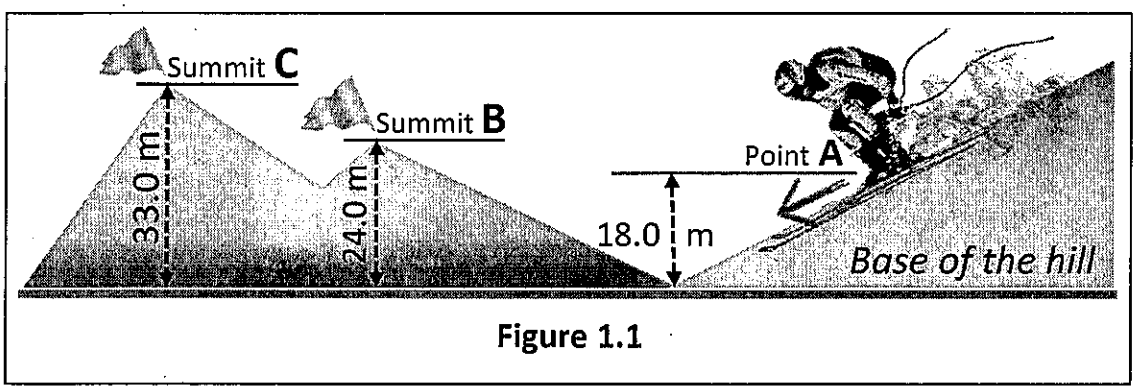


Figure 1.1

(a) Refer to **Figure 1.1**. A skier is gliding down a hill. At point **A**, the skier is **18.0 meters** above the base of the hill (ground level) and is gliding downwards with a *velocity* of **12.8 m/s**. Two other snow covered hills, with summits **B** and **C** are **24.0 meters** and **33.0 meters** from the base of the hill. The skier glides (without any effort from himself) from point **A** to summit **B** and finally to summit **C**. Take g = 9.8 m/s^2. Assume that *friction* can be ignored and use the *conservation of energy principle* to solve the following:

(i) What is the skier's expected *velocity* at summit **B**? **(2 marks)**

(ii) If the skier glides from point **A** to summit **B** and then proceeds to glide towards summit **C** but fails to reach summit **C**, how high up summit **C** can the skier reach? (Answer either the *vertical* distance above summit **B** or below summit **C**). **(2 marks)**

(iii) **2nd attempt**: If the skier tries again to reach summit **C** through gliding without further effort from himself from point **A**, what is the **new** *velocity* he must have at point **A** to be successful in his 2nd attempt to glide all the way up to summit **C**? **(3 marks)**

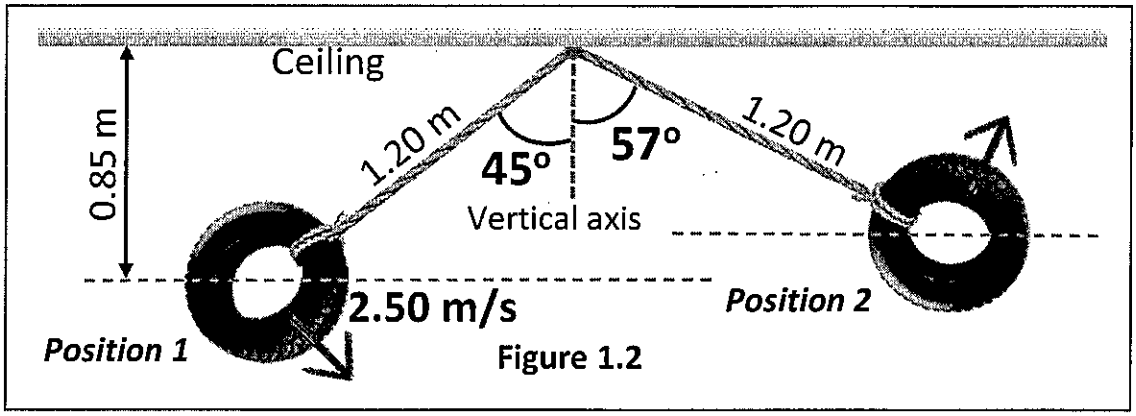


Figure 1.2

(b) Refer to **Figure 1.2**. A tire is tied with a rope and made to swing like a pendulum from the ceiling. The length of this pendulum-like object is measured as **1.20 m** (ceiling to tire's centre). To set the tire in motion, it is raised to a certain height (not given) from the ground level and released (from **rest**) while the rope is taut. When the moving tire makes an angle of **45°** (from *vertical* axis) (***Position 1***), it has a *velocity* of **2.50 m/s** and the tire's centre is **0.85 m** from the ceiling. Take g = 9.8 m/s^2. What is the tire's *velocity* when its angle is **57°** (from *vertical* axis) (***Position 2***)? Hint: use *conservation of energy principle*. **(3 marks)**

Continued...

Question 2 (10 marks)

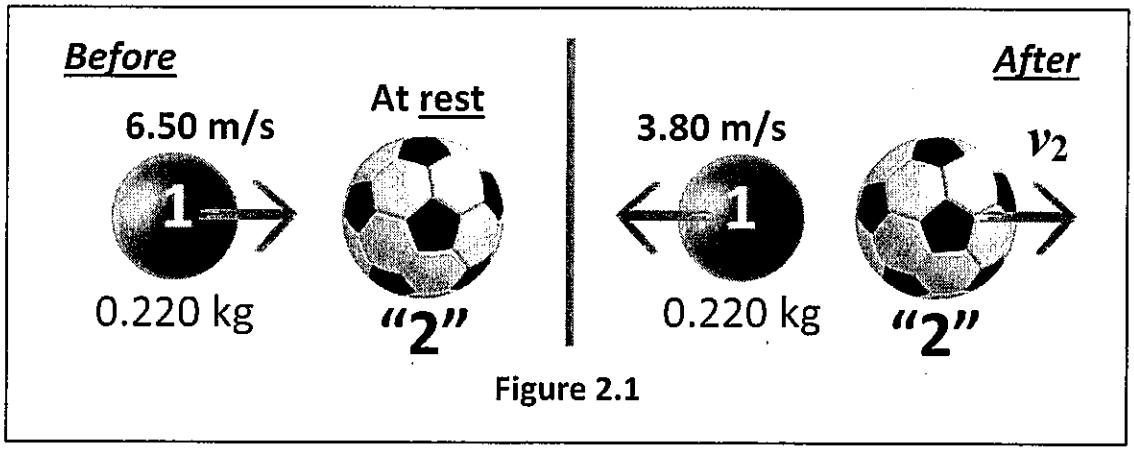


Figure 2.1

(a) Refer to **Figure 2.1**. A **0.220 kg** ball (**Ball "1"**) travelling *horizontally* (+ve x direction) at a *velocity* of **6.50 m/s** collides directly with a second, bigger ball (**Ball "2"**) that is at **rest**. After the collision, the **0.220 kg** ball reverses it direction and now moves with a *velocity* of **3.80 m/s** *opposite* to its initial direction. Note that this collision is ***perfectly elastic***. Based on this information, answer the following:

(i) What is the *velocity* of the second ball (**Ball "2"**) v_2, after the collision? **(3 marks)**

(ii) What is the *mass* of the second ball (**Ball "2"**)? **(2 marks)**

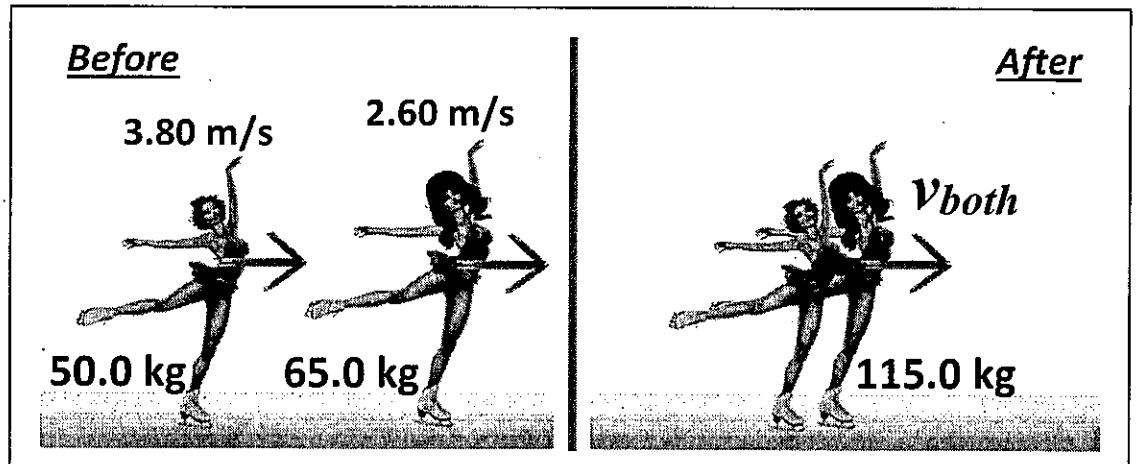


Figure 2.2

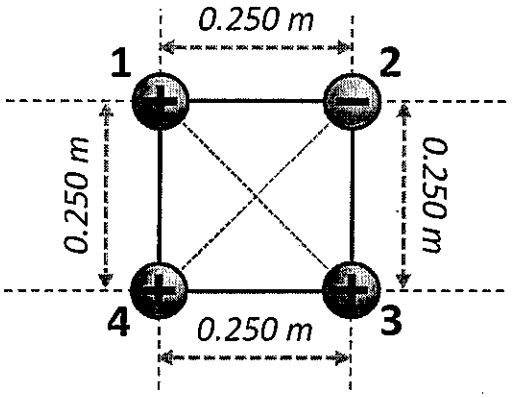
(b) Refer to **Figure 2.2**. An ice-skater moves with a *velocity* of **3.80 m/s** towards the 2nd ice-skater who moves with a *velocity* of **2.60 m/s** in the same direction as the 1st ice-skater. This results in a front to back collision between the two ice-skaters. After the collision, both ice-skaters move together as one single unit with the same *velocity* in the same direction (***perfectly inelastic*** collision). The 1st ice-skater has a mass of **50.0 kg** while the 2nd ice-skater has a mass of **65.0 kg**. Based on this, answer the following:

(i) What is the *velocity*, v_{both}, of the two ice-skaters after the collision? **(2 marks)**

(ii) How much *kinetic energy* is lost in this collision of the two ice-skaters? **(3 marks)**

Continued...

Question 3 (10 marks)



1 = +0.85 μC

2 = −0.85 μC

3 = +0.85 μC

4 = +0.85 μC

Figure 3.1

(a) Refer to **Figure 3.1**. Four point charges are fixed in place at the four corners of a square with sides of the equal lengths of **0.250 m**. These four point charges are labeled (in a clockwise order) as "**1**", "**2**", "**3**" and "**4**" and their respective charges are **+0.85 μC, −0.85 μC, +0.85 μC** and **+0.85 μC**. Take *k*, *Coulomb's constant*, as 9.00×10^9 Nm^2/C^2. Based on this information, answer the following:

(i) Sketch all the four point charges (without indicating the length) in **Figure 3.1** and indicate all the forces acting on each of the four point charges. **(2 marks)**

(ii) What is the net *electrostatic force* on charge "**2**" due to the other three charges? **(5 marks)**

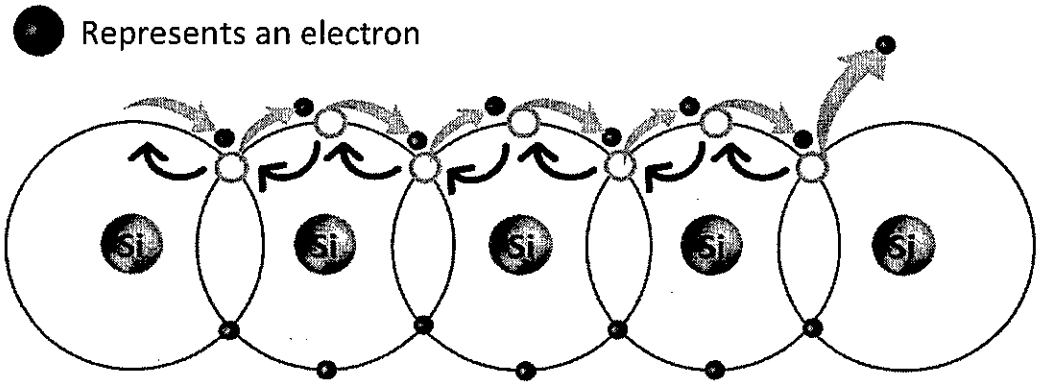


Figure 3.2

(b) Refer to **Figure 3.2**. Besides *electron current*, there is also *hole current* which occurs at the *valence level*. **Figure 3.2** depicts how *hole current* takes place among a row of silicon atoms. With **Figure 3.2** as a guide, briefly describe how *hole current* occurs. **(3 marks)**

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Question 4 (10 marks)

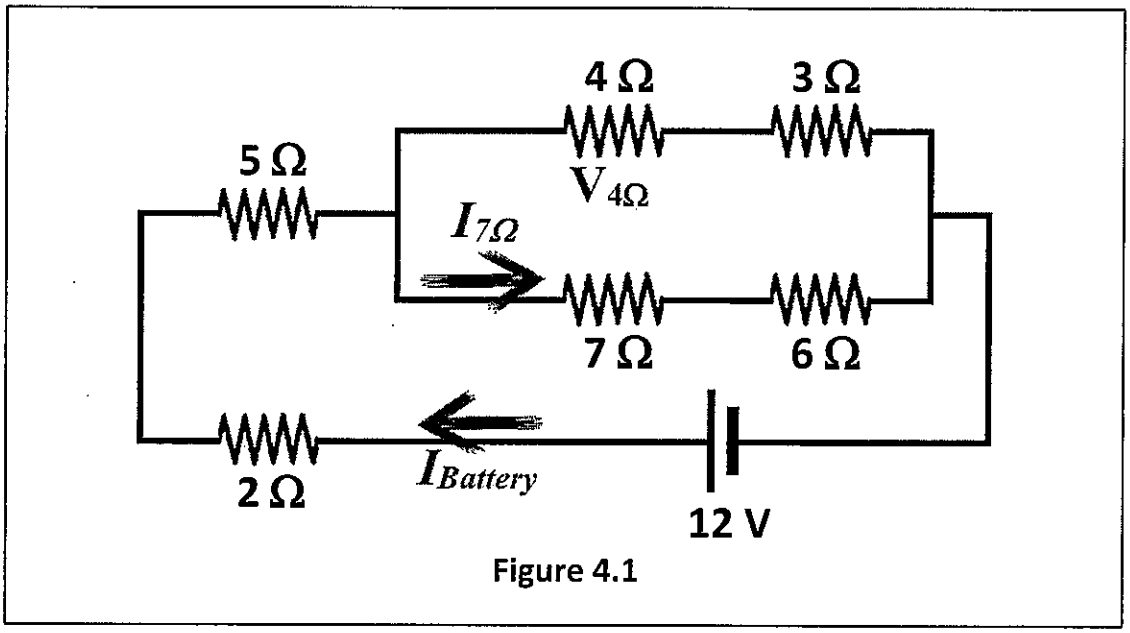

Figure 4.1

(a) Refer to **Figure 4.1**. The circuit above comprises six resistors with different resistances of **2 Ω, 5 Ω, 4 Ω, 3 Ω, 7 Ω** and **6 Ω** arranged in a *series-parallel* combination with a battery source of **12 V**. Based on this, answer the following:

(i) What is the *equivalent resistance* of this circuit? **(1 mark)**

(ii) What is the *current* that flows from the battery ($I_{Battery}$)? **(1 mark)**

(iii) What is the *voltage drop* across the **4 Ω** resistor ($V_{4\Omega}$)? **(1 mark)**

(iv) What is the *current* that flows through the **7 Ω** resistor ($I_{7\Omega}$)? **(1 mark)**

(v) Which of the six resistors has the lowest *power* dissipated? **(2 marks)**

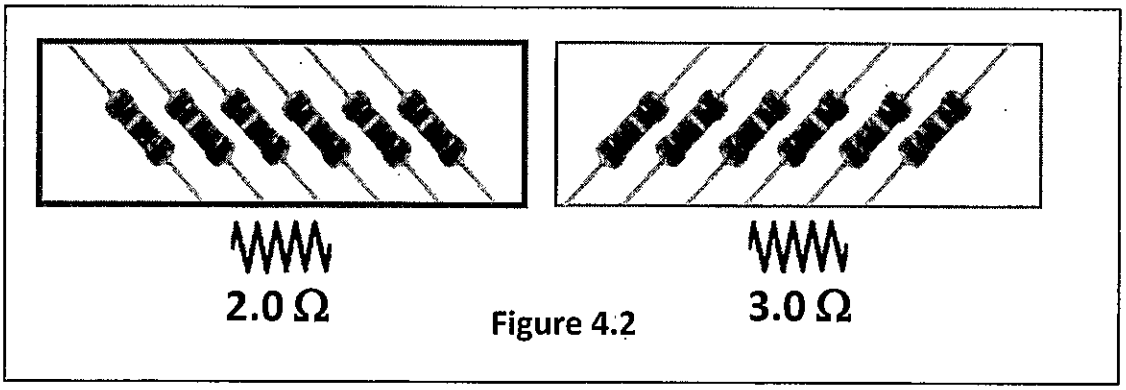

Figure 4.2

(b) Refer to **Figure 4.2**. Consider a *hypothetical* situation: You need a **2.5 Ω resistor** and a **3.6 Ω resistor** but you only have many **2.0 Ω** and **3.0 Ω** resistors. With a clearly labeled drawing of a *series-parallel* combination circuit made up of only **2.0 Ω** resistor(s) and/or **3.0 Ω** resistor(s), show how you can create *series-parallel* combination circuits with the *equivalent resistance* of (i) a **2.5 Ω resistor** and (ii) a **3.6 Ω resistor**. (**Note:** in answering part (i) and (ii), you can use **any** number of the **2.0 Ω** and **3.0 Ω** resistors. **(4 marks)**

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Question 5 (10 marks)

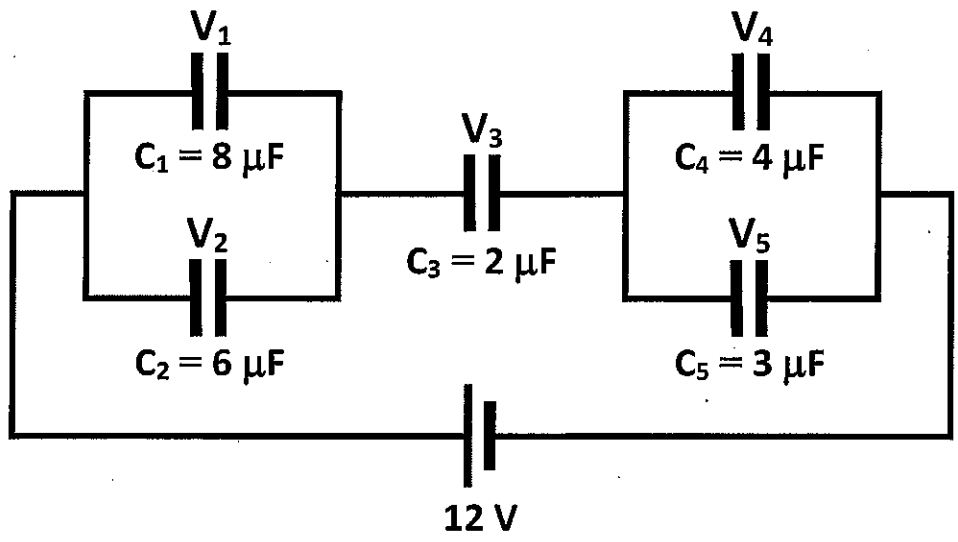

Figure 5.1

(a) Refer to **Figure 5.1**. Five capacitors are arranged in a *series-parallel* combination. Capacitor C_1 (**8 μF**) is connected in *parallel* with capacitor C_2 (**6 μF**). Capacitor C_4 (**4 μF**) is connected in *parallel* with capacitor C_5 (**3 μF**). Then, both $C_1//C_2$ *parallel* capacitors and $C_4//C_5$ *parallel* capacitors are connected in *series* with capacitor C_3 (**2 μF**). A battery, the voltage of **12 V** is applied across this *series-parallel* network of five capacitors. Based on this circuit, answer the following:

(i) What is the *equivalent capacitance* of the circuit in **Figure 5.1**? **(1 mark)**

(ii) What are the *voltages* across the **8 μF** capacitor (V_1), the **6 μF** capacitor (V_2), the **4 μF** capacitor (V_4) and the **3 μF** capacitor (V_5)? **(2 marks)**

(iii) What are the *charges* stored in the **8 μF** capacitor (Q_1), the **6 μF** capacitor (Q_2), the **4 μF** capacitor (Q_4) and the **3 μF** capacitor (Q_5)? **(2 marks)**

(iv) Which of the five capacitors in the *series-parallel* network in **Figure 5.1** can store the **most** *energy*? Provide the relevant calculation/working to support your answer. **(2 marks)**

(b) What is the difference between the following terms?

(i) *Trivalent* element and *pentavalent* element **(1 mark)**

(ii) *Intrinsic* semiconductor material and *extrinsic* semiconductor material **(1 mark)**

(iii) *Majority carrier* and *minority carrier* **(1 mark)**

End of Paper

APPENDIX

LIST OF PHYSICAL CONSTANTS

Acceleration due to gravity	g	$9.8\ \text{m/s}^2$
Electron mass	m_e	$9.11 \times 10^{-31}\ \text{kg}$
Proton mass	m_p	$1.67 \times 10^{-27}\ \text{kg}$
Elementary charge	e	$1.602 \times 10^{-19}\ \text{C}$
Coulomb constant	k	$9.0 \times 10^{9}\ \text{N m}^2\text{. C}^{-2}$
Permittivity of free space	ε_o	$8.85 \times 10^{-12}\ \text{C}^2\ \text{N}^{-1}\text{. m}^{-2}$

LIST OF FORMULA

Quadratic Formula $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ For solving $ax^2 + bx + c = 0$

Kinematics

$v = v_o + at$ $\quad s = \dfrac{1}{2}(v_o + v)t$ $\quad s = v_o t + \dfrac{1}{2}at^2$

$v^2 = v_o^2 + 2as$ $\quad s = vt - \dfrac{1}{2}at^2$

Circular Motion Centripetal acceleration, $a_R = \dfrac{v^2}{r}$ $\quad v = \dfrac{2\pi r}{T}$

Work & Energy $\text{Work, } W = Fd\cos\theta$ $\quad KE = \dfrac{1}{2}mv^2$ $\quad PE_G = mgy$

Momentum $p = mv$

Electricity $F = k\dfrac{q_1 q_2}{r^2}$ $\quad C = \dfrac{\varepsilon_0 A}{d}$ $\quad \boxed{Q = CV}$ $\quad V = Ed$

$C_{eq} = C_1 + C_2 + C_3 + \ldots$ $\quad \dfrac{1}{C_{eq}} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3} + \ldots$

$U = \dfrac{1}{2}QV$ $\quad U = \dfrac{1}{2}CV^2$ $\quad U = \dfrac{Q^2}{2C}$ $\quad \boxed{V = IR}$

$R_{eq} = R_1 + R_2 + R_3 + \ldots$ $\quad \dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} + \ldots$

$P = IV$ $\quad P = I^2R$ $\quad P = \dfrac{V^2}{R}$ $\quad R = \rho\dfrac{L}{A}$